Thesis synopsis

Title: Investigating pattern recognition and bi-coordinate sound localization in the tree cricket species *Oecanthus henryi*

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Acoustic communication, used by a wide variety of animals, consists of the signaler, the signal and the receiver. A change in the behaviour of the receiver after reception of the signal is a prerequisite for communication. A response to the signal by the receiver depends on signal recognition and localization of the signal source. These two aspects, namely recognition and localization by the receiver, form the main body of my work. In the mating system of crickets, the males produce advertisement calls to attract silent females to mate. Females need to recognize the conspecific call and localize the male. The tree cricket *Oecanthus henryi,* due to aspects of its physiology and the environment it inhabits, generates interesting problems concerning these seemingly *simple* tasks of recognition and localization.

In crickets, usually a species-specific sender-receiver match for the call features exists, which aids in recognition. A change in the call carrier frequency with temperature, due to poikilothermy, as seen in *O. henryi,* may pose a problem for this sender-receiver match. To circumvent this, either the response should shift concomitantly with the change in the feature (narrow tuning) or the response should encompass the entire variation of the feature (broad tuning). I explored the response of *O. henryi* females to the changing nature of call carrier frequency with temperature. The results showed that *O. henryi* females are broadly tuned to call carrier frequency. Being broadly tuned I next wanted to explore if within the natural variation in carrier frequency, the females were able to discriminate between frequencies. Females were found not to discriminate between frequencies. Cricket ears being pressure difference receivers are inherently directional, however their directionality is dependent on frequency, which may be affected by the change in carrier frequency due to temperature. Thus I also tested the effect of frequency on the azimuthal localization accuracy. The azimuthal accuracy was not affected by call carrier frequency within the natural range of frequency variability of the species.

In south India, *O. henryi* is found in sympatry with *Oecanthus indicus.* Reproductive isolation between the two is maintained through calls. Since *O. henryi* is broadly tuned to frequency, call carrier frequency is unlikely to enable differentiation between conspecific and heterospecific calls. I thus tested whether the temporal features can account for the same. I constructed a quantitative multivariate model of response space of *O. henryi* incorporating results from various playback experiments. The model predicted high responses for conspecific calls and low responses for heterospecific calls, indicating that temporal features could suffice to discriminate between the two species. The quantitative model could also be used more generally to check responses to other heterospecifics and to compare responses between conspecifics from different populations.

O. henryi is found on a bush and thus the female has to navigate in a 3D environment to localize the singing male. Very few studies have explored 3D localization in insects and moreover an algorithm explaining the procedure is missing. I attempted to model the 3D localization capability in *O. henryi.* To understand the rules behind the localization animals were observed in the wild as well as on a 3D grid in the laboratory and simulations were created to capture the nature of the phonotaxis. Neither a random model nor a deterministic model (which estimated the shortest path) could predict the paths observed in the grid. A less complex Bayesian stochastic model performed better than a more complex one. From the assumptions of the model it was inferred that the animal, for 3D localization, basically performs localization in the azimuthal plane and combines certain simple rules to go up or down.

This study has examined receiver tuning in response to change in carrier frequency with temperature, which to my knowledge had not been explored before for insects. In this study I also attempted to create a quantitative multivariate receiver response space through statistical modeling, a method that can be applied in similar studies across taxa in various acoustic communication systems. A detailed Bayesian algorithm to explain 3D localization for an insect was attempted which has also not been attempted before.